IJSES 3(1) (2026)

International Journal of Science Education and Science

https://journals.balaipublikasi.id/index.php/ijse/index

Trends in Project Based Learning (PjBL) Models for Developing Creative Thinking Skills in Science Learning: A Bibliometric Review (2019–2024)

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Received: December 04, 2024
Revised: August 07, 2025
Accepted: August 12, 2025
Published: March 31, 2026

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Abstract: Education in the 21st century, students need to be equipped with life skills, one of which is creative thinking skills, which are important to face global challenges and rapid technological developments. This study aims to review research trends related to the Project Based Learning (PjBL) model to improve students' creative thinking skills in science learning in the period 2019 to 2024. The method used in this research is descriptive and analytical, with data obtained from scientific publications indexed by Google Scholar, using tools such as Publish or Perish and Dimension.ai. The analysis process was carried out using PRISMA guidelines to filter and assess the quality of documents. Data analysis was conducted through bibliometric analysis with the help of VOSviewer software to map the main keywords. The results showed that the trend of research on PjBL for creative thinking skills continued to increase significantly from 2019 to 2024, but decreased in 2024. Scientific articles are the dominant form of publication, stating that the PjBL model is one of the models that is widely recognized as effective for improving creative thinking skills. Some of the keywords that often appear are "creative thinking skills, critical thinking, PjBL, PBL, motivation, and STEM Project". This research provides a comprehensive view of the development of the PjBL trend in science learning and provides an overview of the use of PjBL in science learning.

Keywords: Bibliometric analysis; Creative thinking skills; Project-based learning; Science learning

Introduction

In the era of 21st century education, the ability to think creatively is one of the essential skills that students must have to face dynamic and complex future challenges. Learning that is oriented towards the development of creative thinking skills is needed, especially in the field of science learning (IPA). One approach that is believed to be able to support the development of these skills is Project Based Learning (PjBL), a learning model that provides opportunities for students to learn through real projects that are relevant to the lives of students.

The Project Based Learning (PjBL) model is a learner-oriented learning model, where learners are engaged in problem solving through complex projects and require the integration of various skills (Vidic, 2023). In PjBL, learners are required to plan, organize and complete projects independently or in groups, which helps them connect theory with real applications (Nilada et al., 2024; Susilawati et al., 2023). In this way, learners not only understand basic concepts in science, but also develop creative and innovative thinking skills that are indispensable in today's global context (Brandt, 2023; Hanif et al., 2019). The PjBL model encourages learners to collaborate, improve communication skills, and strengthen a sense of responsibility, which are important skills in life and the world of work (AlAli et al., 2024; Susilawati et al., 2025).

Creative thinking skills are one of the high-level cognitive skills that are very important in modern education (Doyan et al., 2023). Treffinger (2002) defines

How to Cite:
Sawu, M. R. F. (2026). Trends in Project Based Learning (PjBL) Models for Developing Creative Thinking Skills in Science Learning: A Bibliometric Review (2019–2024). *International Journal of Science Education and Science, 3*(1), xx–xx. https://doi.org/10.56566/ijses.v3i1.273

creative thinking as the ability to generate new ideas, find innovative solutions, and solve problems. In the context of science learning, creative thinking skills are needed to encourage students to be able to overcome scientific challenges through innovative and interdisciplinary approaches (Anindayati et al., 2020). The application of PjBL in science learning provides space for students to experiment and explore various scientific concepts so as to initiate students to think creatively in solving problems (Abas et al., 2024).

Science learning plays an important role in shaping students' understanding of the world around them. Science includes various scientific concepts and principles that underlie natural phenomena (Entress, 2023). Effective science learning should not only emphasize mastery of theory, but also the application of concepts through project-based approaches such as PjBL. The integration of PjBL in science learning can provide a deeper and more meaningful learning experience, which in turn can improve students' creative thinking skills (Krajcik et al., 2014).

To understand research trends related to the use of PjBL models in improving students' creative thinking skills, bibliometric analysis is an appropriate approach. Bibliometric analysis is a quantitative method used to identify publication patterns and research developments in a particular field (Aria et al., 2017). By analyzing publication trends, most frequently researched topics, and collaboration between researchers, we can gain a comprehensive picture of research progress and gaps related to PjBL in science learning.

Method

This research method is descriptive analytical, which aims to understand and describe research trends regarding project-based learning models to improve creative thinking skills. The data used in this study were obtained from scientific publications from sources indexed by Google Scholar, using tools such as Publish or Perish and Dimension.ai. To conduct a search on Google Scholar, keywords related to research trends regarding project-based learning models to improve creative thinking skills in science learning.

In this study, 1,000 documents that have been indexed by Google Scholar between 2019 and 2024 were analyzed. The Google Scholar database was chosen as the document search site because Google Scholar applies consistent standards in selecting documents for inclusion in its index, and Google Scholar displays more documents than other top databases, especially research in the field of education (Hallinger et al., 2020). The analysis process was conducted using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) guidelines to screen and assess document quality. Data analysis was conducted through bibliometric analysis with the help of VOSviewer software to map the main keywords.

Result and Discussion

This study aims to describe research trends on project-based learning models to improve creative thinking skills conducted from 2019 to 2024. Research documents on research trends on project-based learning models to improve creative thinking skills in science learning are taken from documents from 2019 to 2024. The following is presented in Figure 1 regarding research trends on project-based learning models to improve creative thinking in science learning.

Figure 1 shows that the trend of research on the PjBL model to improve creative thinking skills in science learning from 2019 to 2024 has increased. Where the research trend is with an increase in the number of publications each year, namely from 2019 to 2023. However, in 2024 the trend of research on project-based learning models to improve creative thinking skills has decreased. The increasing trend of research on the PjBL model to improve creative thinking skills caused by 21st century education has focused on increasing the competence of creative thinking to solve a problem.

In 2019 there were 100 publications related to the PjBL model to improve creative thinking skills, then it will continue to increase to 780 publications in 2023. This increasing research trend provides a deeper understanding of the problem of low creative thinking skills in science learning and ways to solve the problem. Research is able to improve creative thinking skills through various methods, one of which is a project-based learning model. The following also presents table 1 of PjBL model research to improve creative thinking skills based on the type of publication.

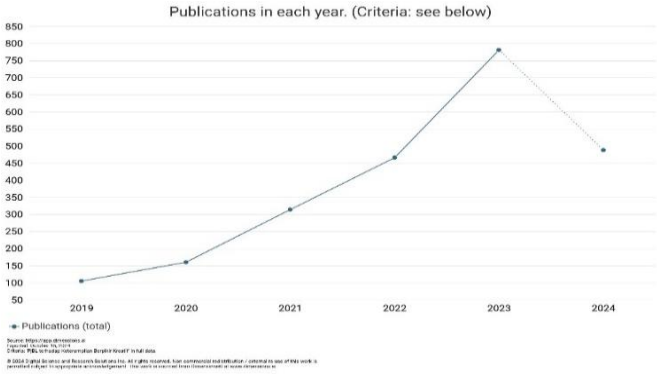

Figure 1. Research trends in PjBL to improve creative thinking skills in science learning (2019–2024)

Based on Table 1, it is known that the research project-based learning model to improve creative thinking skills in science learning from 2019 to 2024 is

found in 5 types of publications. In the form of articles there are 2,371 documents, books as many as 52 documents, proceedings as many as 29 documents, chapters as many as 14 documents, and preprints as many as 2 documents. The research trend of the PjBL model to improve creative thinking skills in science learning in the form of articles is the type of publication that contains the most research results compared to other types of publications. Meanwhile, the type of publication that contains the least research results is preprints. Articles are complete factual essays (Ngalimun, 2022). An article is an essay of a certain length that is made for publication in online or print media (through newspapers, magazines, or newsletters). This article is created with the aim of providing information but also convincing and educating readers through the presentation of verified facts. Through publication media such as scientific journals, articles also meet scientific standards, use formal language, and cite valid sources (Suseno et al., 2020).

Table 1. Trends in PjBL Research to improve Creative Thinking Skills in Science Learning by Publication Type

Publication Type	Publication
Article	2,371
Ediced Book	52
Proceeding	29
Chapter	14
Preprint	2

The following is also presented in Table 2 which presents ten (10) trends in the title of research sources on the PjBL model to improve creative thinking skills in science learning which are often cited by other researchers in this regard.

Table 2. Top 10 Sources of Research Trends Title PjBL to Improve Creative Thinking Skills in Science Learning Research in 2019-2024

Name	Publications	Citations	Citation Mean
Jurnal Penelitian Pendidikan IPA	109	248	2.28
Jurnal Basicedu	72	380	5.28
Advances in Social Science, Education and Humanities Research	64	100	1.56
Edukatif Jurnal Ilmu Pendidikan	46	305	6.63
Jurnal Ilmiah Profesi Pendidikan	27	28	1.04
Social Humanities and Educational Studies (SHEs)	24	5	0.21
AKSIOMA Jurnal Program Studi Pendidikan	23	77	3.35
Journal of Education Action Research	23	38	1.65
Ideguru Jurnal Karya Ilmiah Guru	22	35	1.59
Jurnal Obsesi Jurnal Pendidikan Anak Usia Dini	21	77	3.67

Table 2 shows that the most published research sources on the trend of PjBL models to improve creative thinking skills in science learning have grown significantly. The Science Education Research Journal is a journal that published 109 publications with 248 citations and an average citation of 2.28. The Science Education Research Journal contains scientific articles in the form of research results covering science, technology, and teaching in the field of science. The first edition was published in 2019. All editions in this journal are open access, that is, the articles published in it can be immediately and forever free to read, download, copy and distribute. Below is also presented table 3 trends in the top ten (10) article titles in research on the PjBL model to improve creative thinking skills in science learning that are often cited by other researchers in this regard.

Table 3 shows that research on the PjBL learning model to improve creative thinking skills in science learning that is widely cited by other researchers is about "Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills" which is 121.00 (Zulyusri et al., 2023). Then the research entitled "The Effects of Blended Learning and Project-Based Learning on Pre-service Biology Teachers' Creative Thinking Through Online Learning in the Covid-19 Pandemic" was cited as much as 87.75 per year. Research by Sumarni et al. (2020) entitled "Ethno-STEM Project-Based Learning: Its Impact to Critical and Creative Thinking Skills" is also widely cited by other researchers, amounting to 85.25 per year. Chen et al. (2022) in his research entitled "Effect of project-based learning on development of students' creative thinking" was cited 82.00 per year.

This research data is comparable to the data on the increasing trend of research on the PjBL model to improve creative thinking skills in science learning from 2019 to 2024. This means that in that year, research related to the learning model was continuously cited by other researchers. In the articles researched and written by these researchers, there are many terms related to project-based learning models to improve creative thinking skills in science learning. The following is presented ten (10) popular keywords related to the PjBL model to improve creative thinking skills in science learning.

Table 3. Top 10 Citations on PjBL Research Trends to Improve Creative Thinking Skills in Science Learning Research in 2019-2024

Cities/ Year	Year	Author	Title
121.00	2023	Zulyusri Zulyusri, Ida Elfira, Lufri, Tomi Apra Santosa	Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills
87.75	2020	Yustina, W. Syafii, R. Vebrianto	The Effects of Blended Learning and Project-Based Learning on Pre-service Biology Teacher' Creative Thingking Through Online Learning in the Covid-19 Pandemic
85.25	2020	W. Sumarni and S. Kadarwati	Ethno-STEM Project-Based Learning: Its Impact to Critical and Creative Thingking Skills
82.00	2022	Shih Yeh Chen,Chin Feng Lai, Yu Sheng Su	Effect of project-based learning on development of students' creative thinking
50.80	2019	Sofi Hanif, Agus Fany Chandra Wijaya, Nanang Winarno	Enhancing Students' Creativity through STEM Project-Based Learning
38.60	2019	Abdulkadir Rahardjanto & Fauzi Ahmad Husamah	Hybrid-PjBL: Learning Outcomes, Creative Thinking Skills, and Learning Motivation of Preservice Teacher
29.40	2019	Eliyasni, R., Kenedi, A. K., & Sayer, I. M.	Blended learning and project based learning: the method to improve students' higher order thinking skill (HOTS)
7.00	2023	Festo Kiraga	Literature Review: Efforts to Improve Creative Thinking Ability In Science Learning
3.40	2019	Desrianti Sahida, Enny Zarvianti	Development of Problem Based Learning (PBL) practicum guide to improve student Creative Thinking Skills (CTS) in basic physics subject
1.67	2021	Ahmad Farhan, Nurlaili, Susanna,Soewarno, Yusrizal	Students' creative thinking skills and impact on learning outcomes in physics laboratory II academic using the learning model project-based

Table 4 shows that the keyword that often appears related to research on PjBL models to improve creative thinking skills in science learning is STEM Project 6 times with a level of 1.34. The PjBL model is often combined with the STEM approach to improve 21st century skills, including creative thinking skills (Khafah et al., 2023). Table 4 also shows that digital games are also a keyword that often appears in research trends on PjBL models to improve creative thinking skills in science learning, namely 4 times with a relevance of 1.29. The use of Project-Based Learning (PjBL) models integrated with digital games can improve students' creative thinking skills through interactive experiences in solving problems innovatively and collaboratively (Karamustafaoğlu et al., 2023). In addition, motivation and higher-order thinking also have high relevance in the context of PjBL. Motivation and higher order thinking (HOTS) through the PjBL model play an important role in improving learners' creative thinking skills by engaging them in real-world projects that require complex problem solving and collaboration. This combination of motivation and HOTS encourages learners to think critically, take responsibility, and come up with innovative solutions, thus optimizing their creative thinking skills (Loyens et al., 2023).

The following is a visualization achieved by creating a landscape map, which offers a visual representation of subjects related to scientific studies. The results of bibliometric mapping for shared word networks in articles related to the topic of project-based learning models to enhance creative thinking skills in science learning are illustrated in Figure 2.

Table 4. Keywords Research Trends of PjBL to Improve Creative Thinking Skills in 2019-2024

Terms	Occurrences	Relevance
STEM Project	6	1.34
Digital game	4	1.29
Motivation	8	1.02
Higher order thinking	2	0.98
Inquiry	4	0.72
Technology	2	0.55
PjBL	9	0.45
PBL	8	0.39
Creative thinking skill	20	0.38
Critical thinking skill	18	0.29

Figure 2 shows the results of bibliometric keyword mapping of research trends on project-based learning models to improve creative thinking skills in science learning. In Figure 2 there are 122 keyword items that are often used in research on project-based learning models to improve creative thinking skills in science learning from 2019 to 2024. Figure 2 also contains 8 clusters, where the first cluster is red and consists of 29 keyword items, namely thinking creativity, science education, assessment, creativity skills, and others. The

second cluster in green consists of 18 keyword items namely learning, critical thinking skills, pbl, inqury, and others. The third cluster in dark blue consists of 16 keywords namely project, creative thinking ability, curriculum, case study, and others. The fourth cluster in yellow consists of 16 keywords namely creative thinking skills, motivation, hybrid PjBL, model, physics, and others. The fifth cluster in purple consists of 14 keywords, namely problems, skills, collaboration, 4c skills, and others. The sixth light blue cluster consists of 12 keywords, namely classroom, concept, divergent thinking, and others. The seventh cluster in orange consists of 9 keywords, namely critical thinking, activity, work, and others, the eighth cluster in brown consists of 8 keywords, namely development, process, implementation, and others.

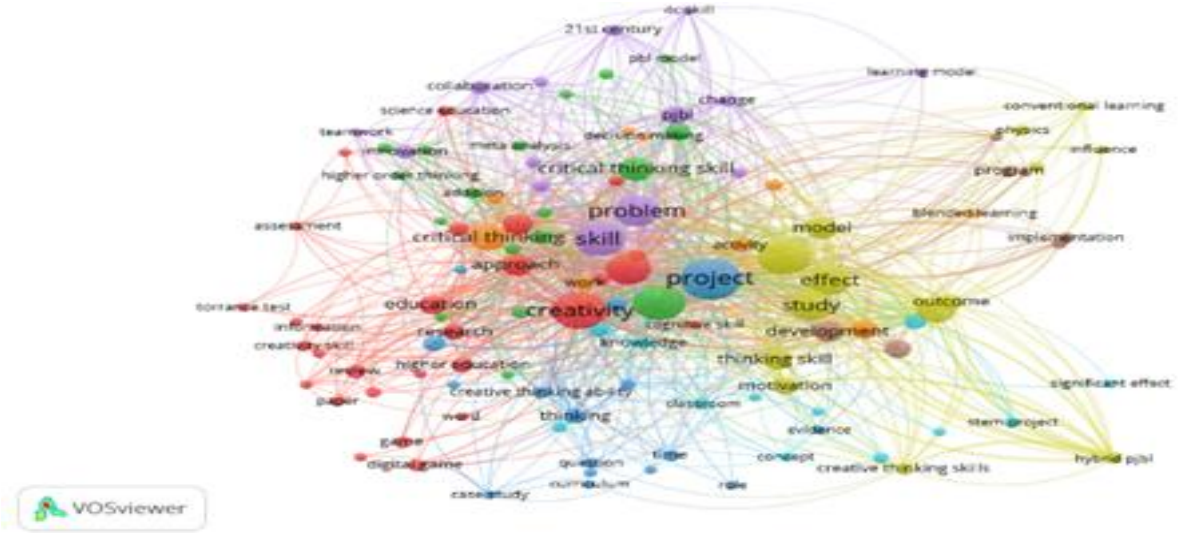

Figure 2. Network visualization on PjBL research trends to improve creative thinking skills in science learning research

Figure 2 also shows that the network visualization shows the network between the visualized terms. The keywords classified into the seven clusters are arranged in a color chart showing the interconnected divisions. The results of this analysis can be used to determine keyword research trends in the last five years. This analysis shows some keywords that are often used in research on project-based learning models to improve creative thinking skills in science learning. The more keywords that appear, the wider the visualization will be. The following also presents keywords regarding project-based learning models to improve creative thinking skills in science learning based on overlay visualization.

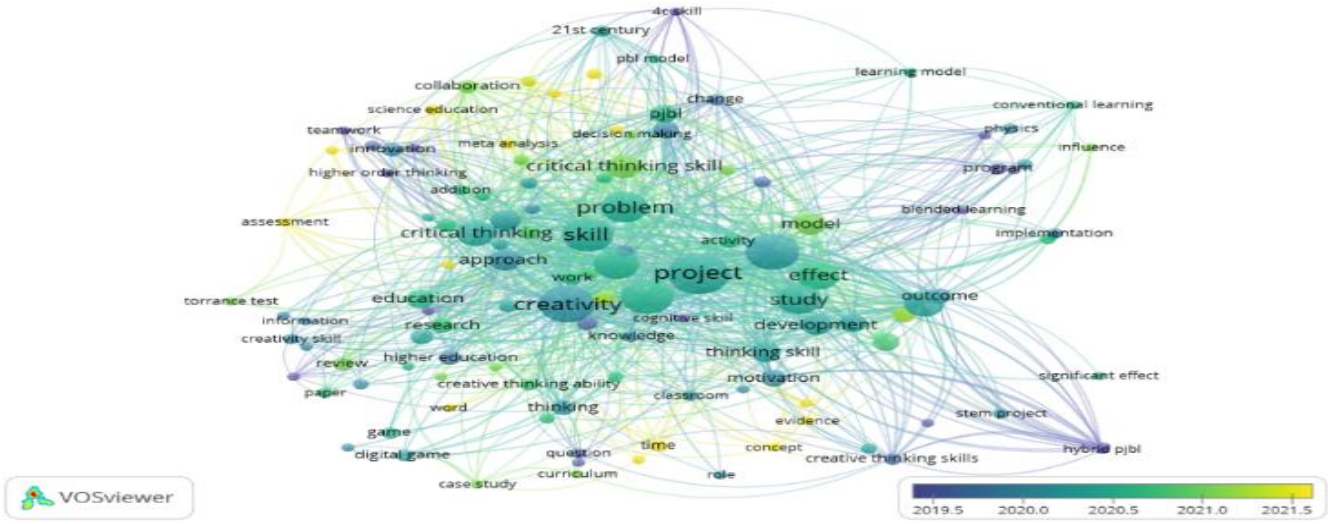

Figure 3. Overlay visualization on PjBL research trends to improve creative thinking skills in science learning research

Figure 3 shows the keyword trends related to research on project-based learning models to improve creative thinking skills in science learning in Google Scholar indexed journals from 2019 to 2024. The theme

trend of writing articles related to project-based learning models to improve creative thinking skills in science learning from the oldest to the latest year is characterized by purple, blue, turquoise, dark green, light green, and yellow themes. In the picture below, it can be seen that in 2019 many keywords such as hybrid pjbl, blended learning, 4c skills, and others were used. In 2020, the keywords project, creativity, creative thinking skills, STEM project and others were widely used. In 2021, the keywords that appear the most are student creative thinking, student critical thinking skills, assessment, science education, and others.

Research on project-based learning models to improve creative thinking skills in science learning is one of the rapidly growing areas of research in recent years. The following also presents keywords for project-based learning models to improve creative thinking skills in science learning research based on density visualization. Figure 4 shows the density visualization. The density of research themes is shown in bright yellow. The brighter the color of the theme, the more research is conducted. The dimmer the color means that the theme is rarely researched (Kaur et al., 2022; Liao et al., 2018). Faintly colored themes such as games, digital games, STEM projects, assessment, science education. This indicates that these keywords can be used as references for further research. Yellow color indicates keywords that are currently and frequently used in research, such as projects, problems, creativity, critical thinking skills, and others.

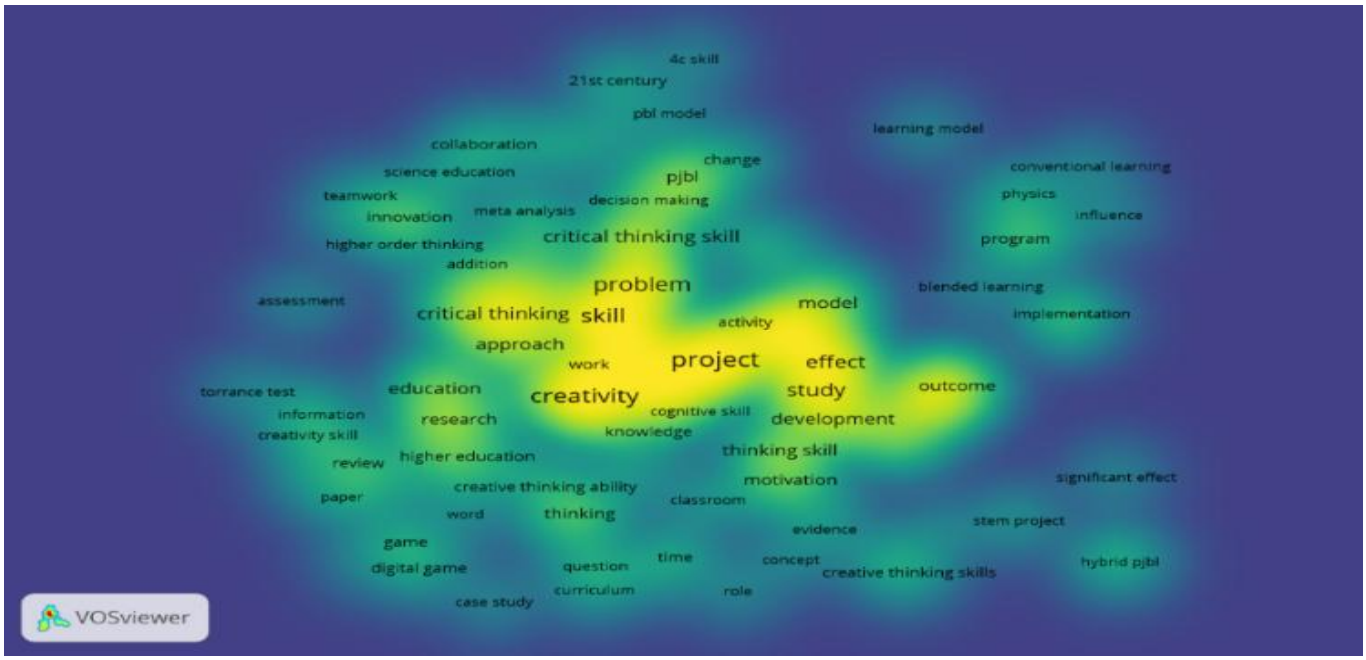

Figure 4. Density visualization on PjBL research trends to improve creative thinking skills in science learning research

Research on PjBL learning models to improve creative thinking skills in science learning has an important role in supporting 21st century education. As part of the 4C skills, creative thinking skills are competencies that students must master to process information in solving problems, both in the context of learning and everyday life (Muliyadi et al., 2023; Suantini et al., 2023; Wijayati et al., 2019). Research trends related to this ability are predicted to continue to grow, especially through the development of technology-based learning media or devices designed to support the strengthening of students' creative thinking skills, especially in science subjects.

Conclusion

Research on trends in project-based learning models to improve creative thinking skills in science learning has a high urgency because of its potential to provide various educational benefits in the 21st century. Research trends in project-based learning models to improve creative thinking skills in science learning indexed by Google Scholar from 2019 to 2023 experienced a fluctuating increase. However, in 2024 there was a decrease in the research trend of project-based learning models to improve creative thinking skills in science learning. There are many documents in the form of articles, proceedings, chapters, preprints, and books that discuss research on project-based learning models to improve creative thinking skills in science learning. The keywords that are often used in research about it are creative thinking skills, critical thinking, PjBL, PBL, motivation, and STEM Project.

Acknowledgments
Thank you to all parties who have helped in this research so that this article can be published.

Author Contributions
All authors contributed to writing this article.

Funding
No external funding.

Conflicts of Interest
No conflict interest.

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